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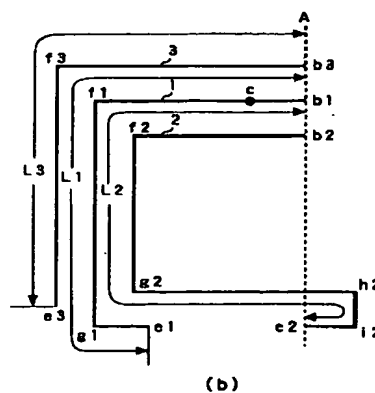
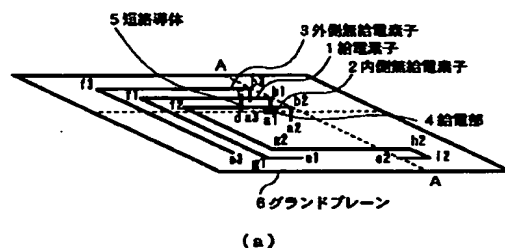
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(54) 【発明の名称】 逆F型アンテナ

(57) 【要約】

【課題】 小型にしても広帯域性を有する逆F型アンテナとする。

【解決手段】 屈曲した給電素子1の外側に平行に外側無給電素子3を屈曲して配置し、屈曲した給電素子1の内側に平行に内側無給電素子2を屈曲して配置する。給電素子1と外側無給電素子3の素子長は等しくされ、内側無給電素子2の素子長はこれより長くされている。これにより、各素子を屈曲して小型化しても、広帯域の周波数特性とすることができる。



【特許請求の範囲】

【請求項1】 グランドプレーンの面と所定間隔離隔された平行な面内において屈曲されると共に、その一端が前記グランドプレーンに向かって略垂直に屈曲されて給電部が形成された給電素子と、

前記グランドプレーンの面と所定間隔離隔された平行な面内において屈曲されると共に、その一端が略垂直に屈曲されて前記グランドプレーンに短絡され、前記給電素子から所定間隔離隔されてその外側に略平行に配置された外側無給電素子と、

前記グランドプレーンの面と所定間隔離隔された平行な面内において屈曲されると共に、その一端が略垂直に屈曲されて前記グランドプレーンに短絡され、前記給電素子から所定間隔離隔されてその内側に略平行に配置された内側無給電素子と、

前記グランドプレーンに略垂直に配置されて、前記給電素子の所定位置と前記グランドプレーン間を短絡する短絡素子とを備え、

前記給電素子と前記外側無給電素子の素子長がほぼ等しくされていると共に、前記内側無給電素子の素子長が前記給電素子の素子長より長くされていることを特徴とする逆F型アンテナ。

【請求項2】 前記内側無給電素子の開放された先端が前記給電素子の開放された先端に向かって屈曲されることにより、小型化されるよう屈曲されていることを特徴とする請求項1記載の逆F型アンテナ。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、広い周波数帯域で動作させることのできる小型の逆F型アンテナに関するものである。

【0002】

【従来の技術】室内や地下等で使用されている防災無線、構内無線、移動体無線等のアンテナとしては、従来ダイポール方式アンテナ、モノポールアンテナ等が使用されていたが、ダイポール方式アンテナ及びモノポールアンテナについては室内や構内の側壁や天井等から突出した取付状態となるために美観を損ねることになっていた。これを解決するために、低姿勢の平面型のアンテナが提案されている。この平面型のアンテナとして、特開平8-78943号公報や特開平8-250925号公報に開示される逆F型アンテナが知られており、その一例の構成を図11(a)に示す。

【0003】この図に示す逆F型アンテナは、等価的に無限の大きさとされたグランドプレーン106と、このグランドプレーン106上に所定間隔離隔されて平行に配置されたL字状の給電素子101と、給電素子101の両側に配置された2本のL字状の無給電素子102、103が設けられている。給電素子101の一端は、垂直にグランドプレーン106側に屈曲されてその先端が

給電部104とされており、その他端は開放されている。さらに、給電素子101の屈曲位置の近傍の所定位置cをグランドプレーン106に短絡させる短絡導体105が設けられている。また、2本の無給電素子102、103の一端は、垂直に屈曲されてその先端がグランドプレーン106に短絡されており、その他端は開放されている。

【0004】グランドプレーン106のa点には図示されていないが貫通孔が形成されており、この貫通孔の部分に図示しない同軸接栓が固着され、その外部導体は貫通孔の周りのグランドプレーン106に接続され、その内部導体は給電素子101の屈曲された先端に接続される。給電素子101の全長、すなわち、給電素子101の屈曲された一端であるa点から先端の開放端であるe点までの長さa-eは、動作中心周波数の波長を λ とすると、 $1/4\lambda$ とされている。また、2本の無給電素子102、103の全長の長さa'-e'も同様に $1/4\lambda$ とされている。また、a点と短絡導体105が設けられるd点までの長さa-dを調整することにより、給電点インピーダンスを調整することができる。

【0005】このような構成の逆F型アンテナの電氣的特性を、図11(b)(c)(d)に示す。図11

(b)はVSWR(電圧定在波比)の周波数特性であり、図11(c)は $\phi=0^\circ$ の面の水平偏波成分と垂直偏波成分の放射パターンであり、図11(d)は $\phi=90^\circ$ の面の水平偏波成分と垂直偏波成分の放射パターンである。なお、図11(c)(d)における測定周波数は設計周波数を f_0 とする時に、 $1.02f_0$ の測定周波数とされており、同図において垂直偏波成分は実線で示されており、水平偏波成分は破線で示されている。図11(b)に示すように、図11(a)に示す構成の逆F型アンテナは、広帯域性を示しており、VSWRが2以下の比帯域は周波数 f_0 に対して約20%となる。また、 $\phi=0^\circ$ 面では水平偏波成分は放射されず垂直偏波成分のみ放射されており、 $\phi=90^\circ$ 面では垂直偏波成分はグランドプレーン106に対して傾いて放射されるようになり、水平偏波成分は上方へ放射されるようになる。

【0006】

【発明が解決しようとする課題】図11(a)に示す逆F型アンテナは比帯域が20%されるために、広帯域性を要求される携帯電話機にも使用することが可能となる。しかしながら、給電素子101および2本の無給電素子102、103は直線状に延伸された形態とされているため、逆F型アンテナの形状は大きいものとなる。従って、小型化が特に要求される携帯電話機等に搭載するには形状が大きすぎるという問題点があった。そこで、これを解決する一手法として給電素子101と2本の無給電素子102、103をグランドプレーン106

と平行する面内において屈曲させることが考えられる。このような考えに基づく逆F型アンテナの構成を図12(a)に示す。

【0007】図12(a)に示す逆F型アンテナは、等価的に無限の大きさとされたグランドプレーン116と、このグランドプレーン116上に所定間隔離隔されて平行に配置されており、その一端部がグランドプレーン116に対して垂直に屈曲された給電素子111と、給電素子111の両側に配置された2本の無給電素子112、113とから構成されている。給電素子111の一端は、垂直にグランドプレーン116側に屈曲されてその先端が給電部114とされており、水平部はグランドプレーン116に平行する面において2カ所で図示するように屈曲されて、その他端が開放されている。さらに、給電素子111の屈曲位置の近傍の所定位置cをグランドプレーン116に短絡させる短絡導体115が設けられている。

【0008】また、2本の無給電素子112、113の一端は、垂直に屈曲されてその先端がグランドプレーン106に短絡されており、水平部はグランドプレーン116に平行する面において1カ所あるいは2カ所で図示するように屈曲されて、その先端が開放されている。この場合、屈曲された2本の無給電素子112、113は、屈曲された給電素子111に平行に配置されるようになる。この逆F型アンテナの給電構造は、図11

(a)に示す逆F型アンテナと同様の構成とされているので省略する。給電素子111の全長、すなわち、給電素子111の屈曲された一端であるa点から先端の開放端であるe点までの長さa-eは、動作中心周波数の波長を λ とするとともに、ほぼ $1/4\lambda$ とされている。また、2本の無給電素子112、113の全長の長さa'-e'も同様にほぼ $1/4\lambda$ とされている。また、a点と短絡導体115が設けられるd点までの長さa-dを調整することにより、給電点インピーダンスを調整することができる。

【0009】このような構成の逆F型アンテナの電気的特性を、図12(b)(c)(d)に示す。図12

(b)はVSWR(電圧定在波比)の周波数特性であり、図12(c)は $\phi=0^\circ$ の面の水平偏波成分と垂直偏波成分の放射パターンであり、図12(d)は $\phi=90^\circ$ の面の水平偏波成分と垂直偏波成分の放射パターンである。なお、図12(c)(d)における測定周波数は設計周波数 f_0 とする時に、 $1/f_0$ の測定周波数とされており、同図において垂直偏波成分は実線で示されており、水平偏波成分は破線で示されている。図12(b)に示すように、図12(a)に示す構成の逆F型アンテナは、動作周波数帯域は低域と高域とで2分されるようになる。また、 $\phi=0^\circ$ 面では水平偏波成分は若干放射され、垂直偏波成分は傾いて放射される。ただし、利得は小さくなり、特に水平偏波成分に対する利得

は小さい。さらに、 $\phi=90^\circ$ 面では $\phi=0^\circ$ 面と同様に水平偏波成分は若干放射され、垂直偏波成分は傾いて放射される。ただし、利得は小さくなり、特に水平偏波成分に対する利得は小さい。

【0010】図12(a)に示す逆F型アンテナは、給電素子111および2本の無給電素子112、113がグランドプレーンと平行な面内において屈曲されているため、小型の逆F型アンテナとすることができる。しかしながら、動作周波数帯域は2分されてしまうことから広帯域性を得ることができないという問題があった。そこで、本発明は小型にしても広帯域性を有する逆F型アンテナを提供することを目的としている。

【0011】

【課題を解決するための手段】上記目的を達成するために、本発明の逆F型アンテナは、グランドプレーンの面と所定間隔離隔された平行な面内において屈曲されると共に、その一端が前記グランドプレーンに向かって略垂直に屈曲されて給電部が形成された給電素子と、前記グランドプレーンの面と所定間隔離隔された平行な面内において屈曲されると共に、その一端が略垂直に屈曲されて前記グランドプレーンに短絡され、前記給電素子から所定間隔離隔されてその外側に略平行に配置された外側無給電素子と、前記グランドプレーンの面と所定間隔離隔された平行な面内において屈曲されると共に、その一端が略垂直に屈曲されて前記グランドプレーンに短絡され、前記給電素子から所定間隔離隔されてその内側に略平行に配置された内側無給電素子と、前記グランドプレーンに略垂直に配置されて、前記給電素子の所定位置と前記グランドプレーン間を短絡する短絡素子とを備え、前記給電素子と前記外側無給電素子の素子長がほぼ等しくされていると共に、前記内側無給電素子の素子長が前記給電素子の素子長より長くされている。

【0012】また、上記逆F型アンテナにおいて、前記内側無給電素子の開放された先端が前記給電素子の開放された先端に向かって屈曲されることにより、小型化されるよう屈曲されていてもよい。

【0013】このような本発明によれば、給電素子と2本の無給電素子とをグランドプレーンと平行な面内において屈曲するようにした際に、内側に位置する無給電素子の長さを長くしたので、動作周波数帯域が2分されることなく広帯域性を有する逆F型アンテナとすることができる。また、給電素子と2本の無給電素子とは屈曲されているので、小型の逆F型アンテナとすることができる。

【0014】

【発明の実施の形態】本発明の逆F型アンテナの実施の形態の第1の構成例を図1(a)(b)に示す。ただし、図1(a)は本発明の第1の逆F型アンテナの斜視図であり、図1(b)は本発明の第1の逆F型アンテナの上上面図である。これらの図に示す逆F型アンテナは、

等価的に無限の大きさとされたグラウンドプレーン6と、このグラウンドプレーン6上に配置された給電素子1と、給電素子1の両側にそれぞれ配置された内側無給電素子2と外側無給電素子3とから構成される。給電素子1は、グラウンドプレーン6に対して略垂直とされた垂直部a1-b1と屈曲された水平部b1-f1-g1-e1から構成される。また、内側無給電素子2は、グラウンドプレーン6に対して略垂直とされた垂直部a2-b2と屈曲された水平部b2-f2-g2-h2-i2-e2から構成され、外側無給電素子3はグラウンドプレーン6に対して略垂直とされた垂直部a3-b3と屈曲された水平部b3-f3-e3から構成される。

【0015】給電素子1の垂直部a1-b1の一端は給電部4とされており、水平部b1-f1-g1-e1はグラウンドプレーン6に平行する面において2カ所で図示するように屈曲されて、その先端が開放されている。さらに、給電素子1における垂直部と水平部との接続点b1の近傍の所定位置cをグラウンドプレーン6に短絡させる短絡導体5が設けられている。短絡導体5の長さc-dは垂直部a1-b1の長さとはほぼ等しくされ、これにより、給電素子1は垂直部a1-b1の長さに相当する間隔だけグラウンドプレーン6から離隔されて、グラウンドプレーン6の面に平行に配置される。また、給電素子1の垂直部の先端a1に対向するグラウンドプレーン6の部分には、図示されていないが貫通孔が形成されており、この貫通孔の部分に図示しない同軸接栓が固着され、その外部導体は貫通孔の周りのグラウンドプレーン6に接続され、その内部導体は給電素子1の垂直部の先端a1に接続される。

【0016】内側無給電素子2の垂直部a2-b2のa2点はグラウンドプレーン6に短絡され、水平部b2-f2-g2-h2-i2-e2は、図示するように4カ所で屈曲され、その先端が開放されている。この内側無給電素子2における屈曲は、給電素子1に内側無給電素子2がグラウンドプレーン6に平行な面内において一定の間隔を保持して平行になるように屈曲されている。なお、内側無給電素子2は垂直部a2-b2の長さに相当する間隔だけグラウンドプレーン6から離隔されて、グラウンドプレーン6の面に平行に配置される。

【0017】さらに、外側無給電素子3の垂直部a3-b3のa3点はグラウンドプレーン6に短絡され、水平部b3-f3-e3は、図示するように1カ所で屈曲され、その先端が開放されている。この外側無給電素子3における屈曲は、給電素子1に外側無給電素子3がグラウンドプレーン6に平行な面内において一定の間隔を保持して平行になるように屈曲されている。なお、外側無給電素子3は垂直部a3-b3の長さに相当する間隔だけグラウンドプレーン6から離隔されて、グラウンドプレーン6の面に平行に配置される。また、給電素子1と内側無給電素子2と外側無給電素子3における水平部の始点b

1、b2、b3は直線であるA-A線上に位置するようにされ、内側無給電素子2における屈曲点h2と屈曲点i2とは、図示するようにA-A線を超えた位置に配置されている。

【0018】ところで、給電素子1の垂直部a1-b1と内側無給電素子2の垂直部a2-b2と外側無給電素子3の垂直部a3-b3と短絡導体5の長さは相互にほぼ等しくされ、給電素子1の水平部b1-f1-g1-e1の長さと、外側無給電素子3の水平部b3-f3-e3の長さとはほぼ等しくされる。また、内側無給電素子2の水平部b2-f2-g2-h2-i2-e2の長さは、給電素子1の水平部b1-f1-g1-e1の長さより長く設定される。例えば、設計周波数1.2[GHz]の波長を λ_0 とした際に、給電素子1の垂直部a1-b1と内側無給電素子の垂直部a2-b2と外側無給電素子の垂直部a3-b3と短絡導体5の長さは、約0.0912 λ_0 とされ、給電素子1の水平部b1-f1-g1-e1と、外側無給電素子3の水平部b3-f3-e3の長さは、約0.176 λ_0 とされ、内側無給電素子2の水平部b2-f2-g2-h2-i2-e2の長さは、約0.223 λ_0 とされる。また、短絡導体5と給電点a1との長さa1-dは、約0.0352 λ_0 とされ、給電素子1および内側無給電素子2との間隔a1-a2と、給電素子1と外側無給電素子3との間隔a1-a3は約0.013 λ_0 とされる。さらに、給電素子1および内側無給電素子2、外側無給電素子3、短絡導体5は、例えば直径約0.004 λ_0 の線材で構成される。

【0019】図1(a)(b)に示す本発明の第1の逆F型アンテナにおける内側無給電素子2の水平部におけるb2-f2の長さとf2-g2の長さとg2からA-A線に接するまでの長さがほぼ等しくなるよう屈曲し、この内側無給電素子2に対して、グラウンドプレーン6に平行な面内において一定の間隔を保持して平行になるように、上記した素子長の給電素子1と外側無給電素子3とを屈曲させた際の電気的特性を、図2および図3に示す。ただし、図2は逆F型アンテナのインピーダンス特性を示すスミスチャートであり、図3はVSWRの周波数特性を示している。また、 $\phi=0^\circ$ 面における放射パターンを図8に示している。図2および図3を参照すると、VSWRは低域において多少2分される傾向を示すが、VSWRが3以下となる比帯域は約29%もの広帯域とされることがわかる。このように、本発明の第1の逆F型アンテナは給電素子1および内側無給電素子2と外側無給電素子3とを屈曲して小型化を図るようにしても、比帯域を広帯域とすることができることから、携帯電話機等の小型化・広帯域性を必要とされる通信システムに適用して好適なアンテナとすることができる。

【0020】ここで、給電素子1および2本の無給電素子2、3をグラウンドプレーン6と平行な面内において屈

曲しても、本発明の第1の逆F型アンテナは図12

(b)に示す従来例のようにVSWRの周波数特性が2分されずに広帯域になる理由について説明する。図12

(a)に示す構成の逆F型アンテナを種々の手法により解析したところ、図12(b)に示す低域の共振周波数 f_L を含む周波数特性は外側に配置された無給電素子112の作用により変えられるものであり、図12(b)に示す2分された高域における低い方の共振周波数 f_H 近傍の周波数特性は内側に配置された無給電素子113の作用により変えられることがわかった。さらに、給電素子111と無給電素子113との作用により2分された高域における広帯域の周波数特性が変えられている。ここで、共振周波数 f_H を低域へシフトするようにすれば、共振周波数 f_H が共振周波数 f_L に近接されるので、周波数特性は2分されずに広帯域の周波数特性とすることができるようになる。これを実現するために、本発明の第1の逆F型アンテナでは内側無給電素子2の素子長を長くして共振周波数 f_H を低域へシフトするようにしている。

【0021】次に、本発明の逆F型アンテナの実施の形態の第2の構成例を図4および図5に示す。ただし、図4は本発明の第2の逆F型アンテナの斜視図であり、図5は本発明の第2の逆F型アンテナの上面図である。図4および図5に示す第2の逆F型アンテナは、次の点で図1(a)(b)に示す第1の逆F型アンテナと異なる構成とされている。図1(a)(b)に示す本発明の第1の逆F型アンテナでは、給電素子1と内側無給電素子2と外側無給電素子3における水平部の始点 b_1 、 b_2 、 b_3 はA-A線上に位置するようにされ、内側無給電素子2における屈曲点 h_2 と屈曲点 i_2 とは、図示するようにA-A線を越えた位置に配置されている。これに対して、図4および図5に示す第2の逆F型アンテナは、給電素子1と内側無給電素子2と外側無給電素子3における水平部の始点 b_1 、 b_2 、 b_3 はA-A線上に位置するようにされると共に、内側無給電素子2における屈曲点 h_2 と屈曲点 i_2 も、図示するようにA-A線上の位置に配置されるよう、水平部 $b_2-f_2-g_2-h_2-i_2-e_2$ が屈曲されている。

【0022】その他の構成においては、本発明の第2の逆F型アンテナは本発明の第1の逆F型アンテナと同様の構成とされているので、その説明は省略する。この本発明の第2の逆F型アンテナにおける給電素子1の垂直部 a_1-b_1 と内側無給電素子2の垂直部 a_2-b_2 と外側無給電素子3の垂直部 a_3-b_3 と短絡導体5の長さは相互にほぼ等しくされ、給電素子1の水平部 $b_1-f_1-g_1-e_1$ の長さ、外側無給電素子3の水平部 $b_3-f_3-e_3$ の長さは、内側無給電素子2の水平部 $b_2-f_2-g_2-h_2-i_2-e_2$ の長さより長く設定される。例えば、設計周波数1.2〔GHz〕の波長を λ_0 とし

た際に、給電素子1の垂直部 a_1-b_1 と内側無給電素子2の垂直部 a_2-b_2 と外側無給電素子3の垂直部 a_3-b_3 と短絡導体5の長さは、約 $0.0912\lambda_0$ とされ、給電素子1の水平部 $b_1-f_1-g_1-e_1$ と、外側無給電素子3の水平部 $b_3-f_3-e_3$ の長さは、約 $0.176\lambda_0$ とされ、内側無給電素子2の水平部 $b_2-f_2-g_2-h_2-i_2-e_2$ の長さは、約 $0.223\lambda_0$ とされる。また、短絡導体5と給電点 a_1 との長さ a_1-d は、約 $0.0352\lambda_0$ とされ、給電素子1および内側無給電素子2との間隔 a_1-a_2 と、給電素子1と外側無給電素子3との間隔 a_1-a_3 は約 $0.013\lambda_0$ とされる。さらに、給電素子1および内側無給電素子2、外側無給電素子3、短絡導体5は、例えば直径約 $0.004\lambda_0$ の線材で構成される。

【0023】図4および図5に示す本発明の第2の逆F型アンテナにおける内側無給電素子2の水平部における b_2-f_2 の長さと f_2-g_2 の長さと g_2-h_2 の長さがほぼ等しくなるよう屈曲し、この内側無給電素子2に対して、グランドプレーン6に平行な面内において一定の間隔を保持して平行になるように、上記した素子長の給電素子1と外側無給電素子3とを屈曲させた際の電氣的特性を、図6、図7および図8に示す。ただし、図6は逆F型アンテナのVSWRの周波数特性であり、図7はそのインピーダンス特性を示すスミスチャートである。図6および図7を参照すると、VSWRは低域においてほとんど2分される傾向がなくなっており、VSWRが3以下となる比帯域は約27%もの広帯域とされることがわかる。このように、本発明の第2の逆F型アンテナは給電素子1および内側無給電素子2と外側無給電素子3とを屈曲して小型化を図るようにしても、比帯域を広帯域とすることができることから、携帯電話機等の小型化・広帯域性を必要とされる通信システムに適用して好適なアンテナとすることができる。

【0024】上記した本発明にかかる逆F型アンテナの給電素子1および内側無給電素子2と外側無給電素子3は線材で構成すると説明したが、本発明はこれに限らず金属材からなる線条や、細長い帯状の板または管等で形成することもできる。ところで、いずれの材料で本発明にかかる逆F型アンテナを形成する場合にも、その材料の太さや強度からみて、逆F型アンテナの給電素子1および内側無給電素子2と外側無給電素子3の各水平部の姿勢を、所要の機械的強度で水平に維持し続けるほど強固に構成することは困難である。そこで、これを解決するために、給電素子1および内側無給電素子2と外側無給電素子3とグランドプレーン6との間に誘電率の低いスペーサを介在させ、このスペーサの下面をグランドプレーン6の表面に固定すると共に、スペーサの上面に逆F型アンテナの給電素子1および内側無給電素子2と外側無給電素子3を固着するようにしてもよい。この場合、スペーサの側面に給電素子1および内側無給電素子

2と外側無給電素子3における各垂直部を固着し、スペーサを貫通するよう短絡導体5を取り付ければよい。これにより、機械的強度を大きくすることができ、逆F型アンテナの給電素子1および内側無給電素子2と外側無給電素子3の各水平部の姿勢を、グランドプレーン6に対して平行に維持し続けることができる。

【0025】また、給電点a1に対向してグランドプレーン6に形成した貫通孔の周囲に、高周波特性の良好な絶縁物を充填して接栓の中心導体がグランドプレーン6に接触しないようにしてもよい。さらに、本発明に係る逆F型アンテナの給電素子1および内側無給電素子2と外側無給電素子3の各水平部を、直方体状の誘電体の上面に蒸着等の手段によって形成した金属薄層により形成し、誘電体の側面に同様の手段により給電素子1および内側無給電素子2と外側無給電素子3の各垂直部を形成する。さらに加えて、誘電体に設けた貫通孔内に同様の手段により金属薄層を形成することにより短絡導体5を形成する。そして、誘電体の下面に所定面積の金属板を固着するか、あるいは、誘電体の下面全域に金属薄層を形成してグランドプレーン6とすることにより、本発明の逆F型アンテナを構成するようにしてもよい。

【0026】上記説明した本発明の第1の逆F型アンテナにおいては、短絡導体5と給電点a1との長さa1-dは約0.0352λ₀とされているが、この長さa1-dをパラメータとした際の電氣的特性の変化を図9および図10に示す。図9(a)は、短絡導体5と給電点a1との長さa1-dを約0.02λ₀とした際の逆F型アンテナのインピーダンス特性を示すスミスチャートであり、図9(b)はそのVSWRの周波数特性を示している。図9(a)(b)を参照すると、VSWRは低域において2分される傾向が強く、比帯域も狭い。また、図7に示すインピーダンス特性と比較すると明らかにインピーダンス特性も変化している。

【0027】また図10(a)は、短絡導体5と給電点a1との長さa1-dを約0.052λ₀とした際の逆F型アンテナのインピーダンス特性を示すスミスチャートであり、図10(b)はそのVSWRの周波数特性を示している。図10(a)(b)を参照すると、VSWRは低域において2分される傾向は小さく、VSWRが3以下の比帯域も広い。また、図7に示すインピーダンス特性と比較すると明らかにインピーダンス特性も変化している。上記例示された約0.0352λ₀とされている短絡導体5と給電点a1との長さa1-dは、図9と図10に示す場合の間の数値とされており、図9と図10に示す比帯域より広い比帯域が得られると共に、そのインピーダンス特性も良好な特性となる。このように、短絡導体5と給電点a1との長さa1

-dは例示された数値の近傍とするのが好適である。

【0028】

【発明の効果】本発明の逆F型アンテナは以上のように構成されて、給電素子と2本の無給電素子とをグランドプレーンと平行な面内において屈曲するようにした際に、内側に位置する無給電素子の長さを長くされているので、動作周波数帯域が2分されることなく広帯域性を有する逆F型アンテナとすることができる。また、給電素子と2本の無給電素子とは屈曲されているので、小型の逆F型アンテナとすることができる。

【図面の簡単な説明】

【図1】本発明の逆F型アンテナの実施の形態における第1の構成例の構成を示す斜視図、および、上面図である。

【図2】本発明の第1の逆F型アンテナのインピーダンス特性を示すスミスチャートである。

【図3】本発明の第1の逆F型アンテナのVSWRの周波数特性を示す図である。

【図4】本発明の逆F型アンテナの実施の形態における第2の構成例の構成を示す斜視図である。

【図5】本発明の逆F型アンテナの実施の形態における第2の構成例の構成を示す上面図である。

【図6】本発明の第2の逆F型アンテナのVSWRの周波数特性を示す図である。

【図7】本発明の第2の逆F型アンテナのインピーダンス特性を示すスミスチャートである。

【図8】本発明の第1の逆F型アンテナの放射パターンを示す図である。

【図9】本発明の逆F型アンテナにおいて、短絡導体の位置を給電点に対して変化させた際のインピーダンス特性を示すスミスチャートである。

【図10】本発明の逆F型アンテナにおいて、短絡導体の位置を給電点に対して変化させた際の他のインピーダンス特性を示すスミスチャートである。

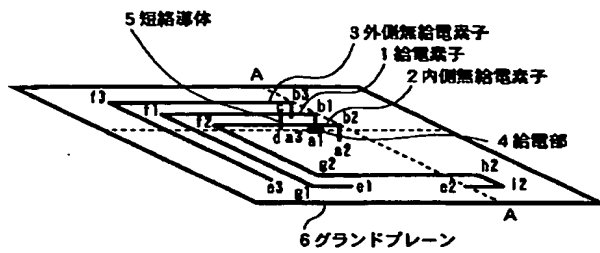
【図11】従来の逆F型アンテナの構成、VSWRの周波数特性、放射パターンを示す図である。

【図12】従来の他の逆F型アンテナの構成、VSWRの周波数特性、放射パターンを示す図である。

【符号の説明】

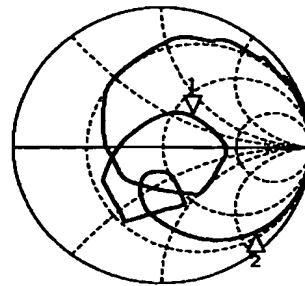
- 1, 101, 111 給電素子
- 2 内側無給電素子
- 3 外側無給電素子
- 4, 104, 114 給電部
- 5, 105, 115 短絡導体
- 6, 106, 116 グランドプレーン
- 112, 113 無給電素子

【図 1】



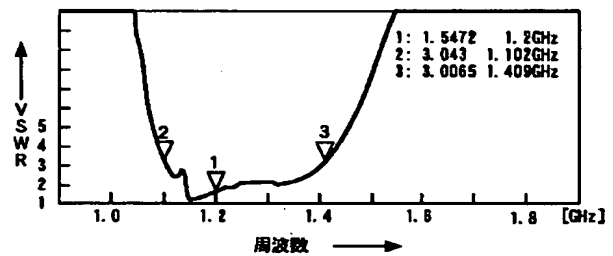
(a)

【図 2】

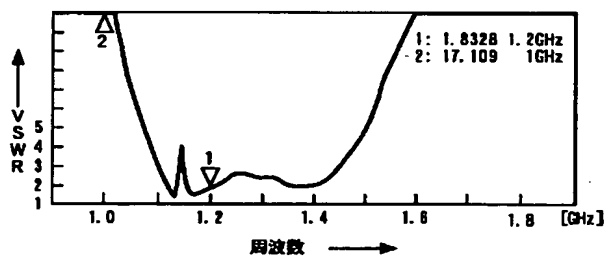


1: 65.34Ω
31.633Ω
1.2GHz
2: 19.879Ω
-119.05Ω
1GHz

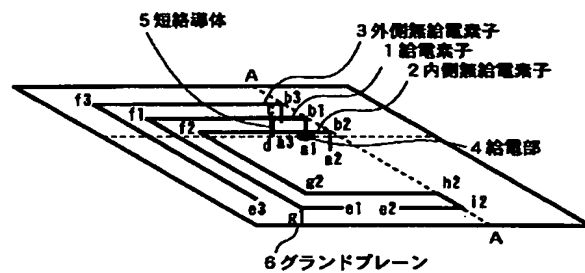
【図 6】



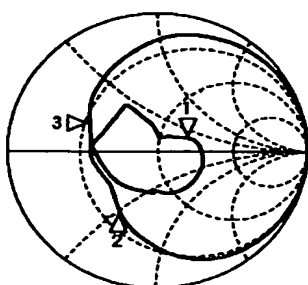
【図 3】



【図 4】

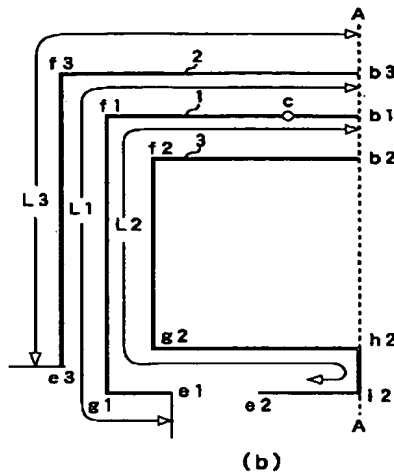


【図 7】

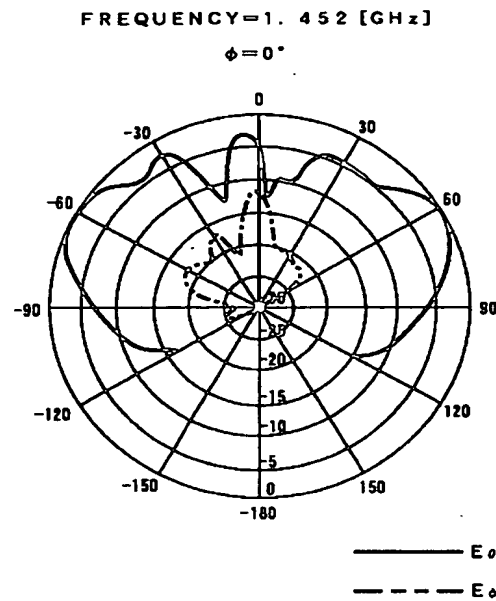


1: 72.619Ω
13.824Ω
1.2GHz
2: 21.742Ω
-26.186Ω
1.102GHz
3: 17.253Ω
9.0742Ω
1.409GHz

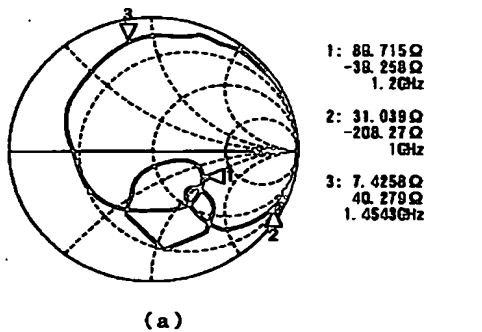
【図5】



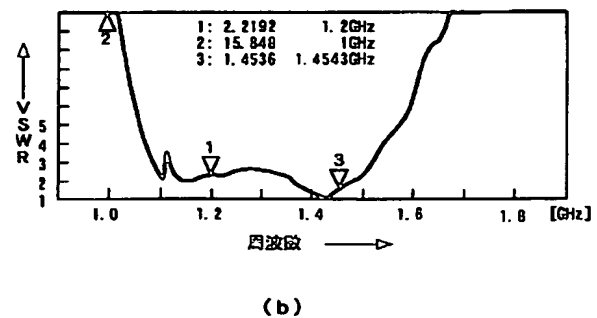
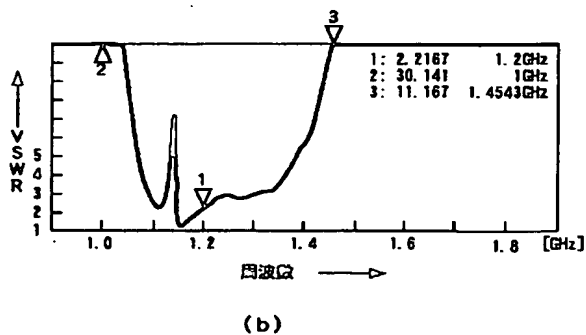
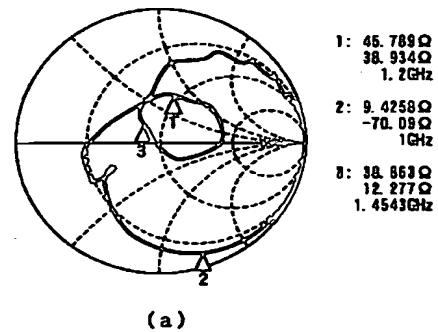
【図8】



【図9】



【図10】



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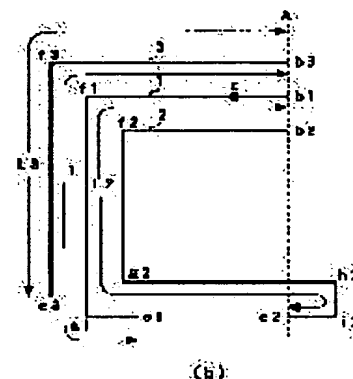
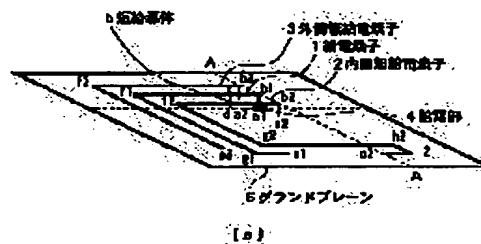
(72)Inventor : SHIMIZU HIROSHI
NAKANO HISAMATSU

(54) INVERTED F-TYPE ANTENNA

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain an inverted F-type antenna which has a wide band characteristics though being made small-sized.

SOLUTION: An outer passive element 3 is bent and arranged in parallel with a bent feed element 1 on the outside of this element 1, and an inner passive element 2 is bent and arranged in parallel with the bent feed element 1 on the inside of this element 1. The same element length is given to the feed element 1 and the outer passive element 3, and the element length of the inner passive element is made longer. Thus, a wide-band frequency characteristics is obtained though each element is bent and miniaturized.



LEGAL STATUS

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[Date of final disposal for application]

[Patent number]

[Date of registration]

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[Date of requesting appeal against examiner's decision of rejection]

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CLAIMS

[Claim(s)]

[Claim 1] A reverse female mold antenna with which element length of said inside passive element is characterized by being made longer than element length of said electric supply element while having the following and making almost equal element length of said electric supply element and said outside passive element. An electric supply element in which the end was crooked in an abbreviation perpendicular toward said ground plane, and the electric supply section was formed while being crooked in a field of a ground plane, and an parallel field by which predetermined gap isolation was carried out An outside passive element which the end was crooked in an abbreviation perpendicular, and connected with said ground plane too hastily, and predetermined gap isolation was carried out from said electric supply element, and has been arranged on the outside at abbreviation parallel while being crooked in a field of said ground plane, and an parallel field by which predetermined gap isolation was carried out An inside passive element which the end was crooked in an abbreviation perpendicular, and connected with said ground plane too hastily, and predetermined gap isolation was carried out from said electric supply element, and has been arranged at abbreviation parallel at the inside while being crooked in a field of said ground plane, and an parallel field by which predetermined gap isolation was carried out A short circuit element which is arranged at an abbreviation perpendicular at said ground plane, and short-circuits between a predetermined location of said electric supply element, and said ground plane

[Claim 2] A reverse female mold antenna according to claim 1 characterized by being crooked so that it may be miniaturized, when a tip where said inside passive element was opened wide is crooked toward a tip where said electric supply element was opened wide.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] This invention relates to the small reverse female mold antenna which can be operated in a large frequency band.

[0002]

[Description of the Prior Art] Since it will be in the attachment condition projected from a side wall, a ceiling, etc. of the interior of a room or premises about the dipole method antenna and the monopole antenna, the fine sight was to be spoiled as antennas, such as disaster prevention wireless currently used in the interior of a room, underground, etc., yard wireless, and mobile wireless, although the dipole method antenna, the monopole antenna, etc. were used conventionally. In order to solve this, the antenna of a low-profile plane mold is proposed. As this plane type of an antenna, the reverse female mold antenna indicated by JP,8-78943,A and JP,8-250925,A is known, and the configuration of that example is shown in drawing 11 (a).

[0003] The electric supply element 101 of the shape of L character which predetermined gap isolation of the reverse female mold antenna shown in this drawing was carried out on the ground plane 106 made into the magnitude of infinity equivalent and this ground plane 106, and has been arranged in parallel, and the passive element 102,103 of the two shape of L character arranged at the both sides of the electric supply element 101 are formed. The end of the electric supply element 101 is perpendicularly crooked in a ground plane 106 side, the tip is made into the electric supply section 104, and the other end is opened wide. furthermore, the short circuit which short-circuits the predetermined location c near the crookedness location of the electric supply element 101 with a ground plane 106 — the conductor 105 is formed. Moreover, the end of two passive elements 102,103 was crooked perpendicularly, the tip has connected it with the ground plane 106 too hastily, and the other end is opened wide.

[0004] Although not illustrated by a points of a ground plane 106, the through tube is formed, the coaxial plug which is not illustrated into the portion of this through tube fixes, that outer conductor is connected to the surrounding ground plane 106 of a through tube, and that inner conductor is connected at the tip at which the electric supply element 101 was crooked. When setting wavelength of working heart frequency to λ , the overall length of the electric supply element 101, i.e., length a-e from a points which are the ends at which the electric supply element 101 was crooked to e points which are the open ends at a tip, is set to about $1/4\lambda$. Moreover, length a'-e' of the overall length of two passive elements 102,103 is similarly set to about $1/4\lambda$. moreover, a points and a short circuit — feeding point impedance can be adjusted by adjusting length a-d to d points in which a conductor 105 is formed.

[0005] The electrical characteristics of such a reverse female mold antenna of a configuration are shown in drawing 11 (b), (c), and (d). Drawing 11 (b) is the frequency characteristic of VSWR (voltage standing wave ratio), drawing 11 (c) is the radiation pattern of the horizontally-polarized-wave component of a $\phi=0$ -degree field, and a vertically-polarized-wave component, and drawing 11 (d) is the radiation pattern of the horizontally-polarized-wave component of a $\phi=90$ -degree field, and a vertically-polarized-wave component. In addition, the test frequency

in drawing 11 (c) and (d) is made into the test frequency of $1.02f_0$ when setting layout frequency to f_0 , the vertically-polarized-wave component is shown by the continuous line in this drawing, and the horizontally-polarized-wave component is shown by the dashed line. As shown in drawing 11 (b), the reverse female mold antenna of a configuration of being shown in drawing 11 (a) shows broadband nature, and, as for two or less fractional bandwidth, VSWR becomes about 20% to frequency f_0 . Moreover, in respect of $\phi = 0$ degree, a horizontally-polarized-wave component is not emitted, but only the vertically-polarized-wave component is emitted, a vertically-polarized-wave component inclines to a ground plane 106, and comes to be emitted, and a horizontally-polarized-wave component comes to be emitted upwards in $\phi = 90$ -degree side.

[0006]

[Problem(s) to be Solved by the Invention] Since a fractional bandwidth is carried out 20%, the reverse female mold antenna shown in drawing 11 (a) becomes possible [using it also for the portable telephone of which broadband nature is required]. However, since the electric supply element 101 and two passive elements 102,103 are made into the gestalt extended in the shape of a straight line, the configuration of a reverse female mold antenna will become large.

Therefore, there was a trouble that a configuration was too large in carrying in the portable telephone with which especially a miniaturization is demanded. Then, it can consider making the electric supply element 101 and two passive elements 102,103 crooked in the field which is parallel to a ground plane 106 as a way method which solves this. The configuration of a reverse female mold antenna based on such an idea is shown in drawing 12 (a).

[0007] The reverse female mold antenna shown in drawing 12 (a) consists of an electric supply element 111 for which predetermined gap isolation is carried out on the ground plane 116 made into the magnitude of infinity equivalent, and this ground plane 116, it is arranged in parallel, and that end section was perpendicularly crooked to the ground plane 116, and two passive elements 112,113 arranged at the both sides of the electric supply element 111. The end of the electric supply element 111 is perpendicularly crooked in a ground plane 116 side, the tip is made into the electric supply section 114, a horizontal level is crooked so that it may illustrate by two places in the field which is parallel to a ground plane 116, and the other end is opened wide. furthermore, the short circuit which short-circuits the predetermined location c near the crookedness location of the electric supply element 111 with a ground plane 116 -- the conductor 115 is formed.

[0008] Moreover, the end of two passive elements 112,113 was crooked perpendicularly, the tip has connected it with the ground plane 106 too hastily, a horizontal level is crooked so that it may illustrate by one place or two places in the field which is parallel to a ground plane 116, and the tip is opened wide. In this case, two crooked passive elements 112,113 come to be arranged in parallel with the crooked electric supply element 111. Since it considers as the same configuration as the reverse female mold antenna shown in drawing 11 (a), the electric supply structure of this reverse female mold antenna is omitted. When setting wavelength of working heart frequency to λ , the overall length of the electric supply element 111, i.e., length a-e from a points which are the ends at which the electric supply element 111 was crooked to e points which are the open ends at a tip, is set to about $1/4\lambda$. Moreover, length a'-e' of the overall length of two passive elements 112,113 is similarly set to about $1/4\lambda$. moreover, a points and a short circuit -- feeding point impedance can be adjusted by adjusting length a-d to d points in which a conductor 115 is formed.

[0009] The electrical characteristics of such a reverse female mold antenna of a configuration are shown in drawing 12 (b), (c), and (d). Drawing 12 (b) is the frequency characteristic of VSWR (voltage standing wave ratio), drawing 12 (c) is the radiation pattern of the horizontally-polarized-wave component of a $\phi = 0$ -degree field, and a vertically-polarized-wave component, and drawing 12 (d) is the radiation pattern of the horizontally-polarized-wave component of a $\phi = 90$ -degree field, and a vertically-polarized-wave component. In addition, the test frequency in drawing 12 (c) and (d) is made into the test frequency of $1.1f_0$ when considering as the layout frequency f_0 , the vertically-polarized-wave component is shown by the continuous line in this drawing, and the horizontally-polarized-wave component is shown by the dashed line. As shown

in drawing 12 (b), a clock frequency band comes to be carried out for the reverse female mold antenna of a configuration of being shown in drawing 12 (a) in low-pass and a high region for 2 minutes. Moreover, in respect of $\phi = 0$ degree, a horizontally-polarized-wave component is emitted a little, and a vertically-polarized-wave component inclines and is emitted. However, gain becomes small and the gain especially over a horizontally-polarized-wave component is small. Furthermore, in respect of $\phi = 90$ degrees, a horizontally-polarized-wave component is emitted a little like $\phi = 0$ -degree side, and a vertically-polarized-wave component inclines and is emitted. However, gain becomes small and the gain especially over a horizontally-polarized-wave component is small.

[0010] Since the electric supply element 111 and two passive elements 112,113 are crooked in the field parallel to a ground plane, the reverse female mold antenna shown in drawing 12 (a) can be used as a small reverse female mold antenna. However, since a clock frequency band will be carried out for 2 minutes, it had the problem that broadband nature could not be obtained. Then, even if this invention is small, it aims at offering the reverse female mold antenna which has broadband nature.

[0011]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, a reverse female mold antenna of this invention While being crooked in a field of a ground plane, and an parallel field by which predetermined gap isolation was carried out While being crooked in an electric supply element in which the end was crooked in an abbreviation perpendicular toward said ground plane, and the electric supply section was formed, a field of said ground plane, and an parallel field by which predetermined gap isolation was carried out An outside passive element which the end was crooked in an abbreviation perpendicular, and connected with said ground plane too hastily, and predetermined gap isolation was carried out from said electric supply element, and has been arranged on the outside at abbreviation parallel, While being crooked in a field of said ground plane, and an parallel field by which predetermined gap isolation was carried out An inside passive element which the end was crooked in an abbreviation perpendicular, and connected with said ground plane too hastily, and predetermined gap isolation was carried out from said electric supply element, and has been arranged at abbreviation parallel at the inside, While being arranged at an abbreviation perpendicular at said ground plane, having a short circuit element which short-circuits between a predetermined location of said electric supply element, and said ground plane and making almost equal element length of said electric supply element and said outside passive element Element length of said inside passive element is made longer than element length of said electric supply element.

[0012] Moreover, in the above-mentioned reverse female mold antenna, when a tip where said inside passive element was opened wide is crooked toward a tip where said electric supply element was opened wide, it may be crooked so that it may be miniaturized.

[0013] Since according to such this invention the length of a passive element located inside was lengthened when an electric supply element and two passive elements were made to be crooked in a field parallel to a ground plane, it can consider as a reverse female mold antenna which has broadband nature, without carrying out a clock frequency band for 2 minutes. Moreover, since an electric supply element and two passive elements are crooked, they can be used as a small reverse female mold antenna.

[0014]

[Embodiment of the Invention] The 1st example of a configuration of the gestalt of operation of the reverse female mold antenna of this invention is shown in drawing 1 (a) and (b). However, drawing 1 (a) is the perspective diagram of the 1st reverse female mold antenna of this invention, and drawing 1 (b) is the plan of the 1st reverse female mold antenna of this invention. The reverse female mold antenna shown in these drawings consists of a ground plane 6 made into the magnitude of infinity equivalent, an electric supply element 1 arranged on this ground plane 6, and the inside passive element 2 and the outside passive element 3 which have been arranged at the both sides of the electric supply element 1, respectively. The electric supply element 1 consists of vertical section a1-b1 made into the abbreviation perpendicular to the ground plane 6, and horizontal level b1-f1-g1-e1 which were crooked. Moreover, the inside passive element 2

consists of vertical section a2-b2 made into the abbreviation perpendicular to the ground plane 6, and horizontal level b2-f2-g2-h2-i2-e2 which were crooked, and the outside passive element 3 consists of vertical section a3-b3 made into the abbreviation perpendicular to the ground plane 6, and horizontal level b3-f3-e3 which were crooked.

[0015] The end of vertical section a1-b1 of the electric supply element 1 is made into the electric supply section 4, horizontal level b1-f1-g1-e1 is crooked so that it may illustrate by two places in the field which is parallel to a ground plane 6, and the tip is opened wide. furthermore, the short circuit which short-circuits the predetermined location c near the node b1 of the vertical section and horizontal level in the electric supply element 1 with a ground plane 6 — the conductor 5 is formed. a short circuit — length c-d of a conductor 5 is made almost equal to the length of vertical section a1-b1, thereby, only the gap equivalent to the length of vertical section a1-b1 is isolated from a ground plane 6, and the electric supply element 1 is arranged in parallel with the field of a ground plane 6. Moreover, although not illustrated by the portion of the ground plane 6 which counters at the tip a1 of the vertical section of the electric supply element 1, the through tube is formed in it, the coaxial plug which is not illustrated into the portion of this through tube fixes, that outer conductor is connected to the surrounding ground plane 6 of a through tube, and that inner conductor is connected at the tip a1 of the vertical section of the electric supply element 1.

[0016] a2 point of vertical section a2-b2 of the inside passive element 2 is connected with a ground plane 6 too hastily, horizontal level b2-f2-g2-h2-i2-e2 are crooked by four places so that it may illustrate, and the tip is opened wide. The crookedness in this inside passive element 2 is crooked so that the inside passive element 2 may hold a fixed gap and may become parallel in a field parallel to a ground plane 6 at the electric supply element 1. In addition, only the gap equivalent to the length of vertical section a2-b2 is isolated from a ground plane 6, and the inside passive element 2 is arranged in parallel with the field of a ground plane 6.

[0017] Furthermore, a3 point of vertical section a3-b3 of the outside passive element 3 is connected with a ground plane 6 too hastily, horizontal level b3-f3-e3 are crooked by one place so that it may illustrate, and the tip is opened wide. The crookedness in this outside passive element 3 is crooked so that the outside passive element 3 may hold a fixed gap and may become parallel in a field parallel to a ground plane 6 at the electric supply element 1. In addition, only the gap equivalent to the length of vertical section a3-b3 is isolated from a ground plane 6, and the outside passive element 3 is arranged in parallel with the field of a ground plane 6. Moreover, it is made for the starting points b1, b2, and b3 of the horizontal level in the electric supply element 1, the inside passive element 2, and the outside passive element 3 to be located on the A-A line which is a straight line, and they are arranged in the location which exceeded the A-A line so that the folding point h2 in the inside passive element 2 and folding point i2 might illustrate.

[0018] by the way, vertical section a1- of the electric supply element 1 — vertical section a3-b3 and the short circuit of b1, vertical section a2-b2 of the inside passive element 2, and the outside passive element 3 — the length of a conductor 5 is made almost equal to mutual, and is made almost equal by the length of horizontal level b1-f1-g1-e1 of the electric supply element 1, and the length of horizontal level b3-f3-e3 of the outside passive element. Moreover, the length of horizontal level b2-f2-g2-h2-i2-e2 of the inside passive element 2 is set up for a long time than the length of horizontal level b1-f1-g1-e1 of the electric supply element 1. for example, the time of setting wavelength of layout frequency 1.2 [GHz] to λ_{dao} — vertical section a1- of the electric supply element 1 — vertical section a3-b3 and the short circuit of b1, vertical section a2-b2 of an inside passive element, and an outside passive element — the length of a conductor 5 It is referred to as about $0.0912\lambda_{dao}$, the length of horizontal level b3-f3-e3 of horizontal level b1-f1-g1-e1 and the outside passive element 3 of the electric supply element 1 is set to about $0.176\lambda_{dao}$, and the length of horizontal level b2-f2-g2-h2-i2-e2 of the inside passive element 2 is set to about $0.223\lambda_{dao}$. moreover, a short circuit — length a1-d of a conductor 5 and the feeding point a1 is set to about $0.0352\lambda_{dao}$, and gap a1-a3 of gap a1-a2 with the electric supply element 1 and the inside passive element 2, and the electric supply element 1 and the outside passive element 3 are set to about $0.013\lambda_{dao}$. furthermore, the

electric supply element 1 and the inside passive element 2, the outside passive element 3, and a short circuit -- a conductor 5 -- about [for example, / diameter] -- it consists of wire rods of 0.004λ .

[0019] It is crooked so that the length until it touches an A-A line from the length of b_2-f_2 in the horizontal level of the inside passive element 2 and the length of f_2-g_2 in the 1st reverse female mold antenna of this invention shown in drawing 1 (a) and (b), and g_2 may become almost equal. The electrical characteristics at the time of making the above-mentioned electric supply element 1 and the above-mentioned outside passive element 3 of element length crooked are shown in drawing 2 and drawing 3 so that a fixed gap may be held and it may become parallel in a field parallel to a ground plane 6 to this inside passive element 2. However, drawing 2 is the Smith chart which shows the impedance characteristic of a reverse female mold antenna, and drawing 3 shows the frequency characteristic of VSWR. Moreover, the radiation pattern in $\phi=0$ -degree side is shown in drawing 8. Although VSWR shows the orientation made some in low-pass for 2 minutes when drawing 2 and drawing 3 are referred to, it turns out that the fractional bandwidth from which VSWR becomes three or less is made into about 29% of broadband. Thus, since the 1st reverse female mold antenna of this invention can make a fractional bandwidth a broadband even if it is crooked in the electric supply element 1 and the inside passive element 2, and the outside passive element 3 and attains a miniaturization, it can be applied to the communication system for which a miniaturization and broadband nature, such as a portable telephone, are needed, and can be used as a suitable antenna.

[0020] Here, why the frequency characteristic of VSWR becomes a broadband like the conventional example the 1st reverse female mold antenna of this invention indicates the electric supply element 1 and two passive elements 2 and 3 to be to drawing 12 (b) even if crooked in a field parallel to a ground plane 6, without being carried out for 2 minutes is explained. When the reverse female mold antenna of a configuration of being shown in drawing 12 (a) was analyzed by various technique, the frequency characteristic containing the low-pass resonance frequency f_L shown in drawing 12 (b) is done so by operation of the passive element 112 arranged outside, and it turned out that the frequency characteristic near the resonance-frequency f_H of the lower one in the high region which is shown in drawing 12 (b) and which was carried out for 2 minutes is done so by operation of the passive element 113 arranged inside. Furthermore, the frequency characteristic of the broadband in the high region carried out by the operation with the electric supply element 111 and a passive element 113 for 2 minutes is done so. Here, if resonance frequency f_H is shifted to low-pass, since resonance frequency f_H approaches resonance frequency f_L , the frequency characteristic can be made into the frequency characteristic of a broadband, without being carried out for 2 minutes. In order to realize this, he lengthens the element length of the inside passive element 2, and is trying to shift resonance frequency f_H to low-pass with the 1st reverse female mold antenna of this invention.

[0021] Next, the 2nd example of a configuration of the gestalt of operation of the reverse female mold antenna of this invention is shown in drawing 4 and drawing 5. However, drawing 4 is the perspective diagram of the 2nd reverse female mold antenna of this invention, and drawing 5 is the plan of the 2nd reverse female mold antenna of this invention. The 2nd reverse female mold antenna shown in drawing 4 and drawing 5 is considered as a different configuration from the 1st reverse female mold antenna shown in drawing 1 (a) and (b) the following point. With the 1st reverse female mold antenna of this invention shown in drawing 1 (a) and (b), it is made for the starting points b_1 , b_2 , and b_3 of the horizontal level in the electric supply element 1, the inside passive element 2, and the outside passive element 3 to be located on an A-A line, and they are arranged in the location which exceeded the A-A line so that the folding point h_2 in the inside passive element 2 and folding point i_2 might illustrate. On the other hand, the 2nd reverse female mold antenna shown in drawing 4 and drawing 5 While making it the starting points b_1 , b_2 , and b_3 of the horizontal level in the electric supply element 1, the inside passive element 2, and the outside passive element 3 located on an A-A line Horizontal level $b_2-f_2-g_2-h_2-i_2-e_2$ are crooked so that it may illustrate and the folding point h_2 in the inside passive element 2 and folding point i_2 may also be stationed in the location on an A-A line.

[0022] In other configurations, since the 2nd reverse female mold antenna of this invention is

considered as the same configuration as the 1st reverse female mold antenna of this invention, the explanation is omitted. The length of a conductor 5 is made almost equal to mutual. vertical section a1- of the electric supply element 1 in the 2nd reverse female mold antenna of this invention -- vertical section a3-b3 and the short circuit of b1, vertical section a2-b2 of the inside passive element 2, and the outside passive element 3 -- It is made almost equal by the length of horizontal level b1-f1-g1-e1 of the electric supply element 1, and the length of horizontal level b3-f3-e3 of the outside passive element 3. Moreover, the length of the horizontal level of the inside passive element 2 is set up for a long time than the length of horizontal level b1-f1-g1-e1 of the electric supply element 1. for example, the time of setting wavelength of layout frequency 1.2 [GHz] to λ_{dao} -- vertical section a1- of the electric supply element 1 -- vertical section a3-b3 and the short circuit of b1, vertical section a2-b2 of the inside passive element 2, and the outside passive element 3 -- the length of a conductor 5 It is referred to as about $0.0912\lambda_{dao}$, the length of horizontal level b3-f3-e3 of horizontal level b1-f1-g1-e1 and the outside passive element 3 of the electric supply element 1 is set to about $0.176\lambda_{dao}$, and the length of horizontal level b2-f2-g2-h2-i2-e2 of the inside passive element 2 is set to about $0.223\lambda_{dao}$. moreover, a short circuit -- length a1-d of a conductor 5 and the feeding point a1 is set to about $0.0352\lambda_{dao}$, and gap a1-a3 of gap a1-a2 with the electric supply element 1 and the inside passive element 2, and the electric supply element 1 and the outside passive element 3 are set to about $0.013\lambda_{dao}$. furthermore, the electric supply element 1 and the inside passive element 2, the outside passive element 3, and a short circuit -- a conductor 5 -- about [for example, / diameter] -- it consists of wire rods of $0.004\lambda_{dao}$.

[0023] Are crooked so that the length of b2-f2 in the horizontal level of the inside passive element 2 and the length of f2-g2 in the 2nd reverse female mold antenna of this invention shown in drawing 4 and drawing 5 , and the length of g2-h2 may become almost equal, and this inside passive element 2 is received. The electrical characteristics at the time of making the above-mentioned electric supply element 1 and the above-mentioned outside passive element 3 of element length crooked are shown in drawing 6 , drawing 7 , and drawing 8 so that a fixed gap may be held and it may become parallel in a field parallel to a ground plane 6. However, drawing 6 is the frequency characteristic of VSWR of a reverse female mold antenna, and drawing 7 is the Smith chart which shows the impedance characteristic. When drawing 6 and drawing 7 are referred to, the orientation of VSWR almost carried out in low-pass for 2 minutes is lost, and it turns out that the fractional bandwidth from which VSWR becomes three or less is made into about 27% of broadband. Thus, since the 2nd reverse female mold antenna of this invention can make a fractional bandwidth a broadband even if it is crooked in the electric supply element 1 and the inside passive element 2, and the outside passive element 3 and attains a miniaturization, it can be applied to the communication system for which a miniaturization and broadband nature, such as a portable telephone, are needed, and can be used as a suitable antenna.

[0024] Although it explained that the electric supply element 1 and the inside passive element 2, and the outside passive element 3 of a reverse female mold antenna concerning above-mentioned this invention were constituted from a wire rod, this invention can also be formed with the filament which consists not only of this but of metal material, a long and slender band-like board or a long and slender band-like pipe, etc. By the way, also when forming the reverse female mold antenna applied to this invention with which material, it is difficult [it] to constitute so firmly that it continue maintaining horizontally by the necessary mechanical strength the posture of each horizontal level of the electric supply element 1 of a reverse female mold antenna and the inside passive element 2, and the outside passive element 3, in view of the size and reinforcement of the material. Then, in order to solve this, while making a spacer with a low dielectric constant intervene between the electric supply element 1 and the inside passive element 2, the outside passive element 3, and a ground plane 6 and fixing the inferior surface of tongue of this spacer to the surface of a ground plane 6, you may make it fix the electric supply element 1 and the inside passive element 2, and the outside passive element 3 of a reverse female mold antenna on the upper surface of a spacer. in this case, each vertical section in the electric supply element 1 and the inside passive element 2, and the outside passive element 3 is fixed on the side of a spacer, and a spacer is penetrated -- as -- a short circuit -- what is

necessary is just to attach a conductor 5. Thereby, a mechanical strength being enlarged and maintaining the posture of each horizontal level of the electric supply element 1 of a reverse female mold antenna and the inside passive element 2, and the outside passive element 3 can be continued in parallel to a ground plane 6.

[0025] Moreover, the perimeter of the through tube which countered the feeding point a1 and was formed in the ground plane 6 is filled up with an insulating material with a good RF property, and you may make it the central conductor of a plug not contact a ground plane 6. Furthermore, each horizontal level of the electric supply element 1 of a reverse female mold antenna and the inside passive element 2 concerning this invention, and the outside passive element 3 is formed by the metal thin layer formed in the upper surface of a rectangular parallelepiped-like dielectric with means, such as vacuum evaporation, and each vertical section of the electric supply element 1 and the inside passive element 2, and the outside passive element 3 is formed with the same means as the side of a dielectric, forming a metal thin layer in addition with the means by which it is the same in the through tube prepared in the dielectric, furthermore -- a short circuit -- a conductor 5 is formed. And you may make it constitute the reverse female mold antenna of this invention by fixing the metal plate of predetermined area on the inferior surface of tongue of a dielectric, or forming a metal thin layer throughout the inferior surface of tongue of a dielectric, and considering as a ground plane 6.

[0026] the 1st reverse female mold antenna of this invention which gave [above-mentioned] explanation -- setting -- a short circuit -- although length a1-d of a conductor 5 and the feeding point a1 is set to about $0.0352\lambda_{dao}$, change of the electrical characteristics at the time of making this length a1-d into a parameter is shown in drawing 9 and drawing 10. drawing 9 (a) -- a short circuit -- it is the Smith chart which shows the impedance characteristic of the reverse female mold antenna at the time of setting length a1-d of a conductor 5 and the feeding point a1 to about $0.02\lambda_{dao}$, and drawing 9 (b) shows the frequency characteristic of the VSWR. When drawing 9 (a) and (b) are referred to, the orientation of VSWR carried out in low-pass for 2 minutes is strong, and its fractional bandwidth is also narrow. Moreover, as compared with the impedance characteristic shown in drawing 7, the impedance characteristic is also changing so that clearly.

[0027] moreover, drawing 10 (a) -- a short circuit -- it is the Smith chart which shows the impedance characteristic of the reverse female mold antenna at the time of setting length a1-d of a conductor 5 and the feeding point a1 to about $0.052\lambda_{dao}$, and drawing 10 (b) shows the frequency characteristic of the VSWR. When drawing 10 (a) and (b) are referred to, the orientation for VSWR to be carried out in low-pass for 2 minutes is small, and three or less fractional bandwidth also has large VSWR. Moreover, as compared with the impedance characteristic shown in drawing 7, the impedance characteristic is also changing so that clearly. the short circuit set to about $0.0352\lambda_{dao}$ by which instantiation was carried out [above-mentioned] -- length a1-d of a conductor 5 and the feeding point a1 is made into the numeric value of the between in the case of being shown in drawing 9 and drawing 10, and it becomes a property also with the good impedance characteristic while the fractional bandwidth larger than the fractional bandwidth shown in drawing 9 and drawing 10 is obtained. thus, a short circuit -- carrying out near the illustrated numeric value is suitable for length a1-d of a conductor 5 and the feeding point a1.

[0028]

[Effect of the Invention] Since the length of the passive element located inside is lengthened when the reverse female mold antenna of this invention is constituted as mentioned above and an electric supply element and two passive elements are made to be crooked in a field parallel to a ground plane, it can consider as the reverse female mold antenna which has broadband nature, without carrying out a clock frequency band for 2 minutes. Moreover, since an electric supply element and two passive elements are crooked, they can be used as a small reverse female mold antenna.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] They are the perspective diagram showing the configuration of the 1st example of a configuration in the gestalt of operation of the reverse female mold antenna of this invention, and a plan.

[Drawing 2] It is the Smith chart which shows the impedance characteristic of the 1st reverse female mold antenna of this invention.

[Drawing 3] It is drawing showing the frequency characteristic of VSWR of the 1st reverse female mold antenna of this invention.

[Drawing 4] It is the perspective diagram showing the configuration of the 2nd example of a configuration in the gestalt of operation of the reverse female mold antenna of this invention.

[Drawing 5] It is the plan showing the configuration of the 2nd example of a configuration in the gestalt of operation of the reverse female mold antenna of this invention.

[Drawing 6] It is drawing showing the frequency characteristic of VSWR of the 2nd reverse female mold antenna of this invention.

[Drawing 7] It is the Smith chart which shows the impedance characteristic of the 2nd reverse female mold antenna of this invention.

[Drawing 8] It is drawing showing the radiation pattern of the 1st reverse female mold antenna of this invention.

[Drawing 9] the reverse female mold antenna of this invention -- setting -- a short circuit -- it is the Smith chart which shows the impedance characteristic at the time of changing the location of a conductor to the feeding point.

[Drawing 10] the reverse female mold antenna of this invention -- setting -- a short circuit -- it is the Smith chart which shows other impedance characteristics at the time of changing the location of a conductor to the feeding point.

[Drawing 11] It is drawing showing the configuration of the conventional reverse female mold antenna, the frequency characteristic of VSWR, and a radiation pattern.

[Drawing 12] It is drawing showing the configuration of other conventional reverse female mold antennas, the frequency characteristic of VSWR, and a radiation pattern.

[Description of Notations]

1,101,111 Electric supply element

2 Inside Passive Element

3 Outside Passive Element

4,104,114 Electric supply section

5,105,115 a short circuit -- conductor

6,106,116 Ground plane

112,113 Passive element

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

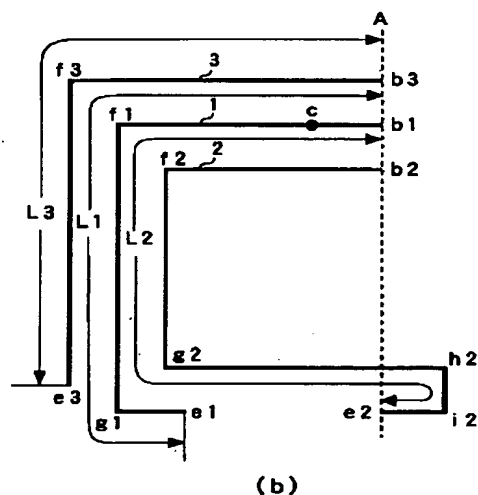
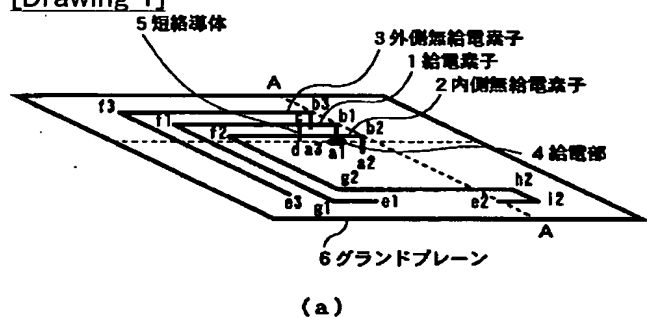
1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

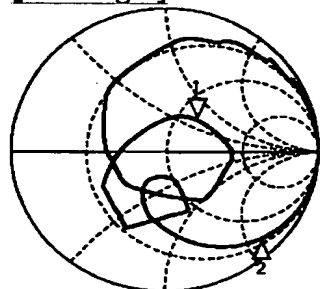
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]

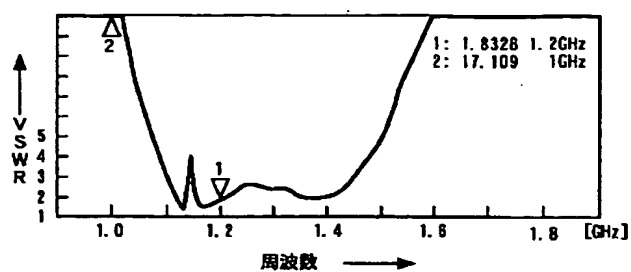


[Drawing 2]

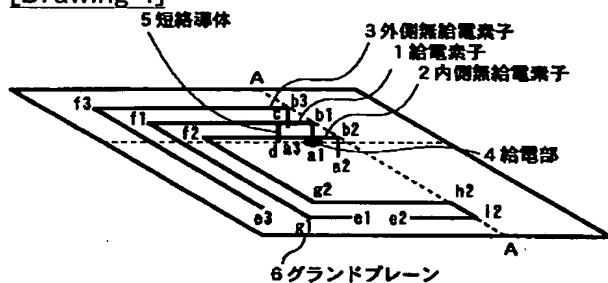


1: 65.34Ω
31.633Ω
1.2GHz
2: 19.879Ω
-119.05Ω
1GHz

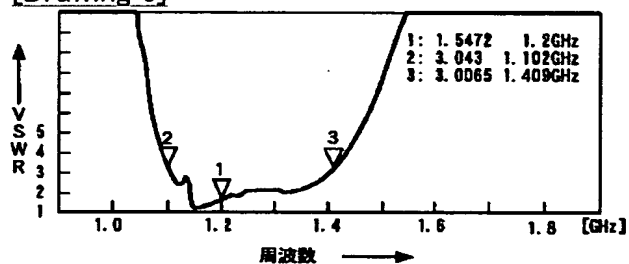
[Drawing 3]



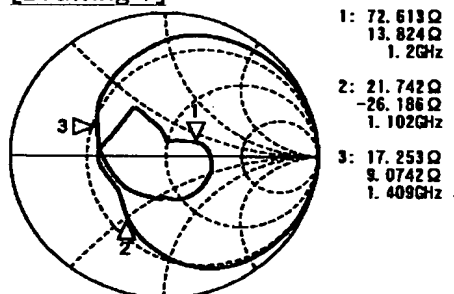
[Drawing 4]



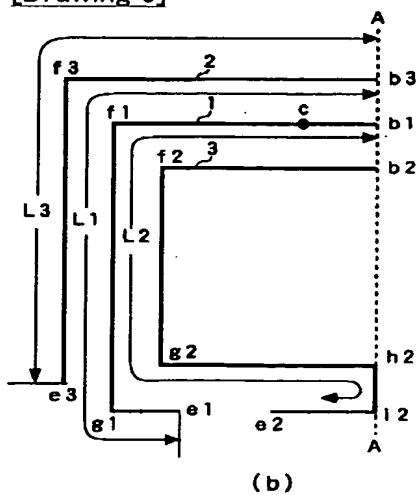
[Drawing 6]



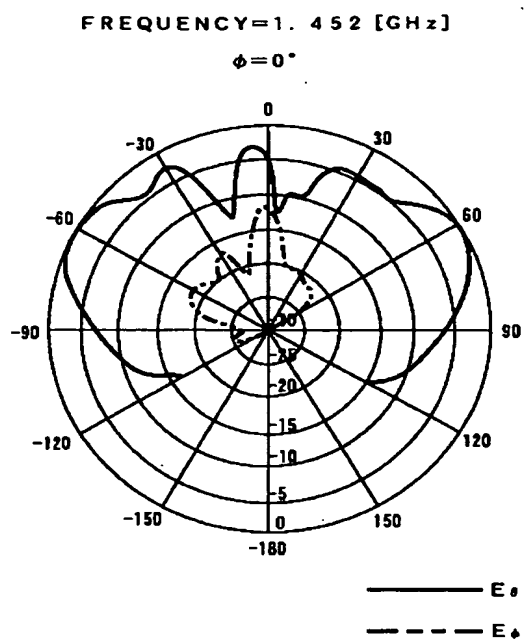
[Drawing 7]



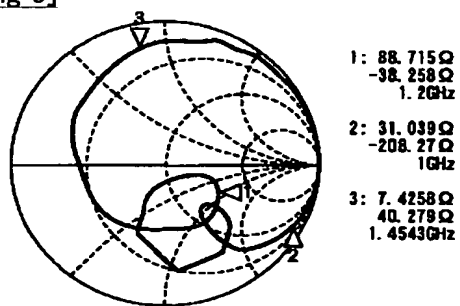
[Drawing 5]



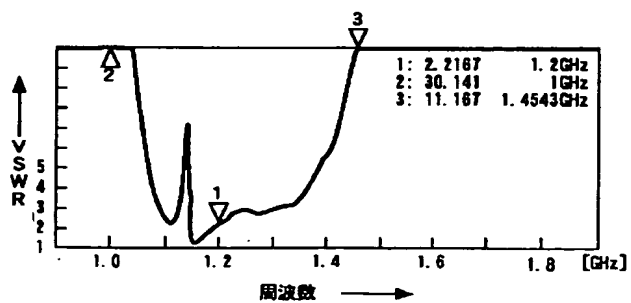
[Drawing 8]



[Drawing 9]

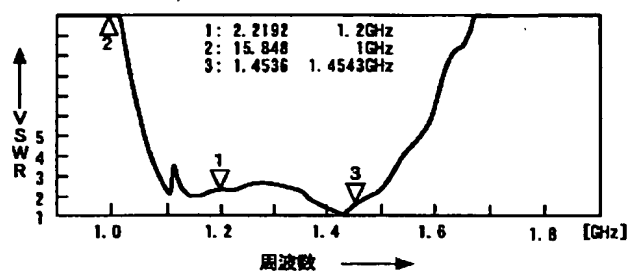
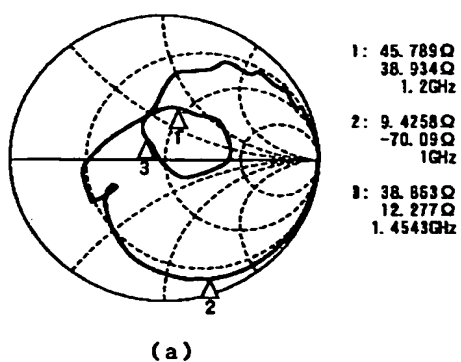


(a)



(b)

[Drawing 10]



[Drawing 11]

